JET PROPULSION LABORATORY INTEROFFICE MEMORANDUM

June 28, 2007

TO: D. Morris

FROM: S. Chhan

SUBJECT: PHX 70M Continuous Requirement Study

The Phoenix Mission Manager requested the Resource Allocation Planning Service (RAPS) to forecast and analyze the supportability for Phoenix Mission on the DSN 70-Meter subnet and any impacts to other DSN users if Phoenix increases requirements on the DSN 70-Meter subnet. The Phoenix Mission request is for continuous coverage on the 70-Meter Subnet from week 13 through week 21 in 2008 (DOY 085 through DOY 146).

The continuous requirement for the 70-Meter coverage is to track the Phoenix spacecraft during its Mars Approach Phase. The study addresses the 70 Meter subnet loading, the forecasted supportability of Phoenix on the 70-Meter subnet and the individual 70-Meter antenna at each complex (DSS-14, DSS-43, and DSS-63), and impacts to DSN users of the 70-Meter subnet from this increased loading.

Assumptions

The analysis assumes that continuous coverage on the 70-Meter Subnet is equivalent to 7 (8-Hour) passes per week at each complex.

At the time of this study, the results only focuses on significant impacts which are below 80% supportability and for those missions with higher percentage of supportability will not be addressed, but additionally does not indicate that the contentions remain constant in the future as requirements from missions will undergo changes.

The original User Loading Profile (ULP) for Phoenix requiring the 70-Meter subnet is outlined in the graph below, with one hour used for setup (Pre Calibration) and 15 minutes used for teardown (Post Calibration).

PHX ULP Original Request for 2008, Weeks 13-21

		Durations		Calibration										
User	Resource	Ave	Min	Pre	Post	13	14	15	16	17	18	19	20	21
PHX Approach	70M	8.0	4.0	1.00	0.25	2	3	2	3	3	3	3	3	8
PHX Approach	70M/34H,70M/34B1	8.0	4.0	1.00	0.25									10
PHX TCM	70M	8.0	4.0	1.00	0.25			1				1		
PHX TCM	70M/34H	8.0	4.0	1.00	0.25								1	3

Analysis and Methodology

Analysis was accomplished by running forecasts for weeks 13-21 for year 2008 and the intention was to determine the supportability of Phoenix Mars Approach phase from the DSN 70-Meter subnet, and also to understand if the continuous requirements by Phoenix will result in any impacts on DSN users and subnets. Results focus in weeks 13-21 on the supportability percentage after additional requirements were added to the 70-Meter, DSS-14, DSS-43, and DSS-63. Prior to running the forecasts, the Phoenix User Loading Profile (ULP) was amended to include 7 passes per week with 8 hours per pass on DSS-14 and similarly for DSS-43 and DSS-63 separately.

Also a separate PHX ULP was amended by adding 21 passes per week with 8 hours per pass on the 70-Meter subnet. These additional requirements resulted in low supportability percentage for the entire duration in weeks 13-22 and also indicate that Phoenix requirements will not be fully supportable and this additional requirement definitely have major impacts to other DSN users of the 70-Meter subnet. The DSN Antenna Downtime Status and Forecast was also used to show the scheduled downtimes and any critical events that may affect this study and its subject. In particular there are two downtimes at DSS-15 (weeks 08-19) and DSS-54 (weeks 06-19) which did have an impact.

Summary of Results

An analysis on the supportability of Phoenix on the 70-Meter (70M) at all three complexes at Goldstone, Canberra, and Madrid was determined by adding 7 (8-Hour) passes per week at DSS-14, DSS-43, and DSS-63 respectively and independently getting the results for comparison for weeks 13-21 in year 2008. Additionally, the result also focus on the 70-Meter subnet's ability to support the Phoenix continuous coverage request, hence a combined 21 (8-Hour) passes per week was forecasted for weeks 13-21.

The supportability results for weeks 13-21 at each Complex have similar outcome and consistency which is also relevant in the lower supportable percentage of other DSN users of the 70M subnet. The focus of the result will be for the weeks that are below the 80% supportability mark, and from weeks 13-21 in year 2008.

Throughout weeks 13-21, a drastic change from approximately 80% supportability to 60% supportability is notable from comparing the original request of the 70-Meter subnet to the forecasted additional requirements on the 70-Meter subnet. The change in supportability could also be related to the two antennas that are scheduled down, DSS-15 from weeks 8-19 and DSS-54 from weeks 6-19. The downtime of these two antennas causes various missions to shift their requirements to other DSN resources which overall will have a slight impact to all DSN Users requiring these antennas.

Figure 1: 70-Meter Supportability Percentage for all DSN Users in weeks 13-21, 2008

Original 70M Subnet Supportable % before PHX Continuous Request

		Week								
User	Subnet	13	14	15	16	17	18	19	20	21
DSN - All Users	70M	82%	83%	80%	80%	78%	81%	83%	83%	64%

70-Meter Subnet Supportable % result after addition of 21 (8-Hour) tracks per week

		Week								
User	Subnet	13	14	15	16	17	18	19	20	21
DSN - All Users	70M	60%	60%	59%	58%	58%	61%	61%	61%	62%

The results of the Phoenix requirements prior to adding the additional continuous coverage on the 70-Meter antennas indicate that the DSN is capable of supporting all DSN users without much contentions from weeks 13-20 in 2008. The results after the continuous coverage 70-Meter request from Phoenix show supportability for all DSN users averaging 60% in weeks 13 through week 21. This is very similar to the current overload on the 70-Meter subnet we already have in week 21 in the Mars viewperiod.

Week 21 is the week where Phoenix's final approach and EDL had previously requested 18 70-Meter passes. The other Mars missions have requested 10-11 passes. The total combined requirements from all Mars Missions equate to about 28 passes and this is above the maximum that the DSN 70-Meter subnet can provide (21 passes). Hence in figure 1 above, the before and after the PHX additional requirements in week 21 really did not show much of a difference from 64% to 62% in part that the supportability from the 70-Meter was already low.

In comparison, the supportability percentage remains similar when forecasting on individual 70-Meter antennas (DSS-14, DSS-43, and DSS-63). The Phoenix supportability percentage results in lower supportability then that of all the supportability of all DSN users' supportability percentage. The 70-Meter subnet is able to support only 52% of Phoenix's continuous request in week 13, 51% in weeks 14,15, and 17, 48% in week 16, 39% in week 18, 49% in week 19, 47% in week 20 and 44% in week 21. The specific antennas also resulted in low supportable percentage for the Phoenix mission requirements. See Figure 2 below for supportability percentage.

Figure 2: Supportability % Results After PHX Continuous Coverage for weeks 13-21, 2008

Phoenix Supportable Percentage for weeks 13-21 after additional requirements

		Week								
User	Subnet	13	14	15	16	17	18	19	20	21
PHX	70M	52%	51%	51%	48%	51%	39%	49%	47%	44%
PHX	DSS-14	48%	47%	46%	47%	44%	39%	47%	43%	43%
PHX	DSS-43	57%	51%	50%	44%	52%	28%	55%	56%	46%
PHX	DSS-63	48%	58%	63%	57%	65%	53%	49%	52%	45%

The supportability from the 70-Meter for Phoenix throughout the Mars Approach phase indicate a high contention for the 70-Meter subnet at all three complexes. Phoenix's requested continuous coverage will impact specific users like Cassini (CAS), Odyssey (M01O), SOHO, Spitzer (STF), and WMAP as shown in Figures 3 and 4. Phoenix continuous coverage requirements will impact users of the 70-Meter subnet and the overall supportability percentage for the other mission requirements.

CAS shows a drop in supportability percentage throughout weeks 13-21. CAS supportability dropped from 98% to 76% in weeks 13 and quite lower in weeks 15 and 16 from 94% to 61% and 97% to 61% respectively. Further in weeks 16 and 17, CAS supportability dropped from 97% to 61% and from 92% to 58%. The trend continues for CAS throughout weeks 21.

Mars Odyssey (M01O) experience even more significant drop in supportability in week 13, from 66% to 26%, week 14 from 71% to 26%, week 15 from 65% to 23%, week 16 from 65% to 33%, and week 17 from 66% to 22%.

SOHO is also impacted throughout in weeks 13-19 with supportability percentage ranging from as low as 41% to 63%. Other DSN users of the 70-Meter such as STF and WMAP also was impacted from the Phoenix request for continuous coverage on the 70-Meter subnet. Other DSN users including Radio Astronomy, DSN Maintenance, and others will be impacted from the Phoenix continuous requirements on the 70-Meter. Please see Figure 3 and Figure 4 below for comparison of supportability percentage for specific DSN missions before and after additional requests from Phoenix continuous requirements on the 70-Meter subnet.

Figure 3: DSN Users Supportability % Result Before PHX Continuous Coverage for weeks 13-21, 2008

(Before) DSN Users Supportability % Without PHX Continuous Coverage
Without Additional 21(8-Hour) Tracks Per Week on 70M

		Week								
User	Subnet	13	14	15	16	17	18	19	20	21
PHX	70M	98%	95%	84%	95%	93%	93%	79%	80%	57%
CAS Tour	70M	98%	98%	94%	97%	92%	97%	93%	81%	65%
M01O	70M	66%	71%	65%	65%	66%	80%	56%	77%	78%
SOHO	70M	64%	60%	52%	58%	47%	60%	72%	72%	58%
STF	70M	67%	69%	71%	62%	72%	65%	65%	75%	48%
WMAP	70M	91%	99%	88%	89%	87%	85%	93%	90%	79%

Figure 4: DSN Users Supportability % Result After PHX Continuous Coverage for, weeks 13-21, 2008

(After) DSN Users Supportability % With PHX Continuous Coverage
With Additional 21(8-Hour) Tracks Per Week on 70M

		Week								
User	Subnet	13	14	15	16	17	18	19	20	21
PHX	70M	52%	51%	51%	48%	51%	39%	49%	47%	44%
CAS Tour	70M	76%	82%	61%	61%	58%	77%	67%	54%	79%
M01O	70M	26%	26%	23%	33%	22%	66%	67%	71%	74%
SOHO	70M	50%	45%	45%	47%	41%	49%	61%	63%	61%
STF	70M	47%	46%	46%	45%	45%	45%	47%	47%	51%
WMAP	70M	72%	73%	73%	74%	74%	74%	77%	78%	79%

Conclusion

Forecast results reveals that Phoenix continuous coverage requirements will have low supportable percentage below 50% of their request. The additional requirements from Phoenix on the 70-Meter antennas will have major impacts on other DSN users of the 70-Meter subnet and the low supportable percentage will be throughout the requested support from weeks 13 through 21 in year 2008.

Phoenix continuous coverage could possibly be achieved by relying on various 34-Meter subnets as a combination vice requiring only the 70-Meter subnet for continuous support. As an alternative, Phoenix missions can plan on reducing the continuous coverage on the 70-Meter antennas and target specific time-frame to schedule their critical events in weeks with minor contentions for the 70-Meter or attempt to de-conflict weeks with high contentions.

The Results Of This Study Are Subject To Change, In That Network Loading Changes, As Requirements For Planned Missions Are Input And Updated And Periods Of Antenna Downtime Are Identified.